

geleisen it is below one-fourth, and that the average proportion of phosphorus in the samples of spiegeleisen which I have analysed, is less than one-twentieth of the quantity contained in our Cleveland pigs. Three, four, and five hundredths per cent. is the quantity I ordinarily find in good German or Swedish spiegeleisen. The sulphur seldom exceeds one-tenth per cent., and the large quantity of manganese materially assists in the removal of the silicon. It is, in fact, very similar to the Styrian cast-iron, which, as I have already said, does not present the English difficulty of making steel by the direct process. Both are charcoal-irons, made from remarkably rich and pure ores. The manufacture of cast-iron from such ores, and steel from such cast-iron is mere child's-play compared with our native manufacture.

In reference to the second fact that the manufacture of puddled steel has been carried out more successfully on the Continent than in England, I need only say that this confirms my statements, as the puddlers there are less skilful than ours, and their raw material is a vastly superior charcoal-iron, such as I have already described.

The third fact, viz.: that only *mild* steel of inferior quality is made by this process, is further confirmation of what I have said respecting the necessity of removing the carbon from common pig-iron in order to purify it sufficiently to produce good steel; for even with all this skilful selection of the purest pigs, and the mixing of spiegeleisen with them, it is found in this country impracticable to make puddled steel containing more than one-half per cent. of carbon. Such steel is only fit for rails, tyres, for rubbish cutlery, and other purposes where a very soft steel, or rather steely iron, is used. If the puddling were stopped when the carbon was only reduced to about 1.75, or say 1.5 per cent. (the quantity contained in the best hard cast-steel), the puddled steel would be utterly rotten, it would crush under the hammer whether hot or cold; the reason of this being that even with the best English pigs, the selected "steel-irons," there would, with this amount of carbon, still retain a ruinous proportion of silicon, phosphorus, &c. It is necessary with all available advantages to bring down the carbon to within one half per cent. in order to produce a workable material. Even then it is worth only about one third of the price of good cast-steel.

I might illustrate this subject still further by entering into the details of the chemistry of the Bessemer process and of Bessemer steel, by the history of the nitrate of soda process, and of other attempts to manufacture steel directly from cast-iron; but I think the above is sufficient to expose the fundamental fallacy upon which all such attempts have been founded. I hope to have succeeded more particularly in demonstrating the very great error of those who, in their attempts to make such steel, have, like the friend of my correspondent whose letter opens this paper, deliberately chosen cinder-pig or other inferior iron upon which to make their demonstrative experiments. This was the case with the Heaton Company. They worked for a long time at Langley Mill with one of the worst classes of pig-iron they could have selected for their purpose. I pointed this out to them in a letter printed in the *Chemical News* of February 19, 1869. This effort, the most promising of any of the kind, on account of the action of the residual alkaline soda, was, through this serious mistake, never fairly tested. I witnessed some of their experiments, and analysed and otherwise tested the results. There can be little doubt that with properly selected pigs a material similar to puddled or Bessemer steel, may be made by this process, and by several others that have been tried and have failed; but with the common classes of English pig-irons, all such attempts to make steel directly by the partial oxidation of the carbon must of necessity fail, unless some entirely new, some hitherto utterly unknown method of removing the silicon, phosphorus, and sulphur of the pig-iron is also used. In such a case the novelty, the invention, the triumph, would

consist not in the decarburisation of the cast-iron, but in the separation of the other ingredients.

I therefore recommend all inventors who seek to simplify or otherwise improve the manufacture of steel, to direct their attention first to the removal of phosphorus, next to the removal of silicon, thirdly to the removal of sulphur, and last and least of all to mere decarburisation, for that is a problem of the utmost simplicity, and already sufficiently understood.

My next paper will be "On the Chemistry of the Bessemer Process," and will include some original observations, the results of which I believe to be of considerable value to the numerous manufacturers who are now erecting or working Bessemer plant. W. MATTIEU WILLIAMS

SCIENTIFIC SERIALS

POGGENDORFF'S *Annalen der Physik und Chemie*, vol. cxi., part 2.—This number of Poggendorff's *Annalen* contains (1) the conclusion of Ketteler's paper on the theory of Chromatic Dispersion. (2.) The conclusion of Sondhaus's paper on the "tones of heated tubes, and on the vibrations of air in organ-pipes of various shapes." In this part the author compares his formula with Wertheim's experimental results, and shows that in most cases the agreement between them is very close. (3.) The conclusion of Freese's paper on chromates. (4.) "On the work done by gases in motion," by L. Boltzmann. In the first volume of the *Annalen* for 1869 (vol. cxxvi.), a method of determining the specific heat of air under constant volume is described by F. Kohlrausch, the method consisting essentially in observing the cooling effect indicated by a delicate metallic thermometer enclosed in the receiver of an air-pump when the piston is raised. A few months afterwards (Pogg. *Annalen*, vol. cxxxviii.) Kohlrausch's experiments were criticised by A. Kurz, who objected to them that when the air in the receiver of a pump is expanded by drawing up the piston, it does no work; and that, therefore, theoretically, its temperature ought not to fall. This is of course an obvious blunder; and Boltzmann shows, by a strict mathematical discussion of the experiment, that although the pressure of the air against the piston, and therefore the work done by it, is not quite so great when the piston is raised quickly, as it would be if the movement were indefinitely slow, yet the difference is only a quantity of the same order as the ratio of the velocity of the piston to the velocity of sound, and therefore cannot have perceptibly affected Kohlrausch's results. (5.) "Calculation of the vibrations of a string, taking account of its rigidity," by R. Hoppe. (6.) "On asterism and corrosion-figures in crystals," by H. Baumhauer. (7.) "Comparison of the electrophorus with the electrical machine and the electrophorus-machine," by P. Riess. This paper contains some interesting historical notices of early electrical machines, both frictional and such as acted by induction, but we cannot see that it is of any importance as a contribution to the theory of electrical machines. (8.) "On the velocity of molecular motion and that of sound in gases," by E. Mulder. The author seeks to establish a relation between the velocity of sound in a gas and the mean velocity of translation of its molecules, as deduced by Clausius from the dynamical theory of heat. (9.) "On the production of stationary vibrations and sound-figures in liquids and gases by solid sounding plates," by A. Kundt. (10.) "On elastic vibrations," by J. J. Müller. By a modification of Kundt's method of measuring the wave-lengths of vibrating columns of air, the author has succeeded in proving that the velocity of propagation of vibrations of great amplitude is perceptibly greater than that of vibrations of small amplitude, both in the case of columns of air and of elastic rods. (11.) "On Leclanché's Manganese battery," by J. Müller. The author finds that polarisation occurs to a considerable extent in galvanic cells of Leclanché's construction when they are employed in a circuit of small resistance, so that under these circumstances he found the electro-motive force of a Leclanché's cell to be only 0.896 of that of a Daniell's cell, whereas, according to Leclanché, it is equal to 1.38 times the electro-motive force of a Daniell's cell. (12.) "On the occurrence of augite-material in meteorites," by C. Rammelsberg. (13.) "On the Lodran meteorite," by G. Tschermak. (14.) "On acoustic attraction and repulsion," by K. H. Schellbach. Additional facts, but as yet no explanation of these curious phenomena. According to the author, the attraction of light bodies

by a vibrating tuning-fork was observed and described by Guyot in 1834. (15.) "On the maximum-density and freezing point of mixtures of alcohol and water," by F. Rossetti. This is a short extract from the author's researches on the expansion of water and certain solutions, published in greater detail in the *Annales de Chimie et de Physique* for 1867 and 1869 (vols. x. and xv.). (16.) "A Method of Examining the Structure of Flames," by L. Dufour. The flame is cut across horizontally by a flat lamellar jet of water or of air, and can then be examined at leisure by looking down into it from above. (17.) "Remarks on the colour of iodine," by Carl Schultz-Sellack. The author calls attention to the different colour of iodine in the solid state, or when dissolved in water, alcohol, &c., from that which it shows in the state of vapour, or when dissolved in sulphide of carbon, stannic chloride &c., iodine transmitting in the former case chiefly the extreme red rays of the visible spectrum, and, in the latter case, chiefly the blue and violet rays. He argues that this difference of absorptive character between solid or liquid and gaseous iodine is analogous to the difference which exists, according to Magnus, between the absorptive action of liquid and gaseous water on invisible heat-rays. (18.) Prof. Nordenskiöld announces the discovery of platinum as well as gold in the sand of the river Ivalo in North Lapland. (19.) The genuine character of the diamond lately found in Bohemia has been proved by Prof. Schafarik by burning a portion of it in oxygen.

Journal of the Chemical Society, July and August, 1870.—The whole of the July number and 22 pages of the August number of this periodical are occupied by the continuation of the very elaborate and exhaustive paper by Dr. Divers on the combinations of carbonic anhydride with water and ammonia. The half acid ammonium carbonate which was previously considered to be represented by the formula $(\text{CO}_2)_3(\text{OH})_5(\text{NH}_3)_4$ is found by Dr. Divers to contain $(\text{CO}_2)_3(\text{OH})_4(\text{NH}_3)_4$; when exposed to the air it loses water and ammonia, being transformed into the acid carbonate $\text{CO}_2\text{OH}_2\text{NH}_3$, of which 8 modes of preparation are described. Another compound obtained in an impure condition by Rose, is considered by the author to have the composition $(\text{CO}_2)_5(\text{OH})_4(\text{NH}_3)_4$. He also thinks it probable that the orthocarbonate $\text{CO}_2(\text{OH})_2(\text{NH}_3)_4$ or $\text{CO}_4(\text{NH}_3)_4$ exists. The modes of preparation and properties of ammonium carbonate $\text{CO}_2(\text{NH}_3)_2$ are fully described. The formula attributed to the commercial carbonate of ammonia is $(\text{CO}_2)_2\text{OH}_2(\text{NH}_3)_3$. The whole of this memoir bears evidence of most careful research and perseverance; the history of the compounds mentioned is traced out; the modes of preparation and properties are carefully described, and very numerous analyses have been made in order to ascertain their composition. Mr. Charles Griffin describes a new gas furnace for chemical operations at a white heat, which does not require a blowing machine. The gas is supplied to this furnace through a bundle of 16 Bunsen's burners, the upper ends of which are surrounded by a metal jacket fitting into a perforated clay plate supported on a tripod. When large crucibles are to be employed, a plumbago cylinder open at both ends and pierced with holes is placed on the clay plate, the conical crucible being supported by the upper end of the cylinder. The crucible and plumbago cylinder are surrounded by a fireclay cylinder resting on three bronze pennies placed on the lower plate. The cylinder is closed at the top by a clay plate, through which a flue is so made that the current of spent gases is bent twice at right angles before escaping into the sheet-iron chimney; the object of this flue is to check the stream of gas which would otherwise be so great as to cool the furnace very considerably. When small crucibles have to be heated, they must be supported on a grate consisting of a clay plate with a cusped aperture. By means of this furnace, ingots of cast iron 4lbs. in weight have been fused in 2½ hours, starting with a cold furnace; when the furnace is hot, 5lbs. could be fused in the same time; the quantity of gas used is 33 cubic feet per hour. The cylindrical body of the furnace may be replaced by one of an oval shape, and containing a muffle in which many operations may be performed, the temperature inside the muffle being sufficiently elevated to fuse silver, gold, and copper. The remainder of the August number is devoted to the proceedings of the society during the session of 1869-70, and a report of the anniversary meeting held on March 30, the latter including the President's address and obituaries of Mr. Brayley, F.R.S., Dr. Graham, F.R.S., Mr. A. B. Northcote, M.A., Dr. Penny,

F.R.S.E., and of the late foreign members, Drs. Erdmann and Redtenbacher. These are followed by the list of papers read during the year; the balance-sheet, which shows the society to be in a prosperous condition; and the donations to the library.

SOCIETIES AND ACADEMIES

NEW ZEALAND

Wellington Philosophical Society, June 25.—W. B. D. Mantell, F.G.S., president, in his address, directed attention to the large additions made during the past year to the collection of fossil Reptilian remains in the Museum by the officers of the Geological Survey. Several genera are represented, but owing to the nature of the matrix, which exceeds in hardness the most refractory of the "Tilgate" beds, their development will be a work of great difficulty.—Walter Buller, F.L.S., exhibited and described a specimen of the now almost extinct New Zealand Rat or Kiori—in former days a highly valued article of food among the natives, and pointed out its striking resemblance to the ancient black rat of Britain.—T. H. Potts exhibited chicks a few days old of *Anarhynchus frontalis*, showing the characteristic crooked bill, and also the eggs and manner of nidification, along with those of *Charadrius bicinctus*; completely establishing the marked difference between the two birds.—W. T. L. Travers, F.L.S., gave an account of the habits of the Crested Grebe in New Zealand. He has reason to think that they pair for life, and stated that they make additions to the height of their nests, as inundation takes place, but that the eggs will retain their vitality though immersed in water for a considerable time, and inferred that this might have some connection with the coloured mucous layer with which the shell becomes coated during incubation.—Dr. Hector said he had found the nest containing eggs in a tidal lagoon, where it must have risen and fallen with the tide. The eggs were not discoloured. He also exhibited a dusky variety of the bird along with its chick, which is only found on unfrequented inland lakes.—Dr. F. J. Knox exhibited sections of the teeth of a *two-toothed Berardius*, and showed that, from the high state of development, they are not rudimentary as has been surmised, and yet they never appear to protrude through the gum.—John Buchanan exhibited a hybrid between the Australian *Acæna ovina*, which has been lately introduced with imported cattle, and the New Zealand *Acæna sanguisorba*.—Dr. Hector, F.R.S., called attention to the practical importance of knowing what fish belonging to the Salmonidæ are found in the New Zealand streams, as the English trout is being rapidly introduced throughout the country. Only one species, *Retropinna richardsonii* (the New Zealand smelt), is mentioned in the latest works as being found in New Zealand; but he exhibited in addition two very distinct forms, one having the same general character as that fish, but with dentition and form of head of an *Osmerus*. The third form is easily distinguished by its small head, forward position of the dorsal fin, small soft mouth devoid of teeth except a feeble row along the upper jaw. It is the common Opokororo of the natives, and grows to a very considerable size in some of the rivers and lakes. He also exhibited drawings of a specimen of *Scopelus* which he had obtained in Milford Sound, as a fourth fish related to the Salmonidæ.

PARIS

Academy of Sciences, Aug. 22.—A note was read by General Morin on the first session of the international metric commission, held from the 8th to the 13th of August.—A letter was presented by Professor Newcomb of Washington to M. Delaunay on irregularities in the moon's motion due to the influence of the planets.—A note was read from M. Laranja e Oliveira on a remarkable atmospheric electric shock experienced at Porto-Alegre, Brazil, on June 9th.—M. Chapelas reported his observations on the August shooting-stars. He remarked that the year has been distinguished by a smaller number of shooting-stars than has been known for a long period. The periodic display commenced in the last days of July, but the determination of its maximum presented great difficulty, both from the almost constantly clouded condition of the sky, and from the moon being at her full. During the night of the 10th, in which there was an hour and a half favourable for observation, with an average clear sky amounting to 0.6, forty-six shooting-stars were observed, among which were two meteors of the third magnitude. Their mean direction was (as is generally the case, and especially at that hour, 10^h 15^m to 11^h 45^m) from